

Talking about maths

Tony Pye

University of East London

Abstract

In this article, I explore ideas from Jo Boaler's recent (2009) book about children learning mathematics, some views of educationalists and academics and link these to my own observations. The article summarises a key aspect of how children learn effectively and how this is (or is not) supported by teaching methodology. This summary is put into the context of some unpublished research carried out with another colleague some years ago and observations of secondary trainee mathematics teachers. The article looks at the premise that children are encouraged to talk and the reasons why this might be effective in helping them understand concepts better by involving the input of their peers. c.

Keywords: : Pupils' talk; reinforcing learning; More Knowledgeable Others (MKO); problem-solving; teaching and learning.

Introduction

'In maths you have to remember; in other subjects you can think about it.' (Boaler 2009: 35)

I have just finished reading Jo Boaler's book *The elephant in the classroom* (2009). I am currently a teacher-educator (after 35 years teaching mathematics in secondary schools in England), and, as part of my continuing professional interest, this book, with the subtitle *Helping children learn and love maths*, interested me greatly. Boaler sets out some strategies that she has used to help develop, if not a love of mathematics, at least a strong appreciation. Some of her comments resonated strongly with my own long-held beliefs, and will probably do so with many of my secondary colleagues who are currently teaching mathematics.

Background

I have long held the view that children learn mathematics best by being able to talk about it; in fact I believe that children often understand concepts and explanations given by their peers better than the explanations given by us – the teachers! While I was reading the book, I started to draw up a table of my observations about learning which includes talk as opposed to learning in silence, based upon both my personal experiences and my reading:

Working with talk

Collaborative
Supportive (peer-peer)
Ideas testing
Reinforcing learning
Using problem-solving methods
Sharing responsibility for others' learning
Accessing additional information or knowledge as needed
Active

Working in silence

Individual
Rule-following
Responsibility for self only
Can need prompting (cues) more frequently
Passive

(adapted from Pollard 2002: ch. 13)

Observations and arguments

As part of my role as an initial teacher-educator, I visit many schools to observe trainee maths teachers in the classroom. I have observed that in some schools, whole classes of pupils can, at times, be expected to work in silence. When I visit schools to observe the lessons of trainees following our Postgraduate Certificate of Education (PGCE) course, or Graduate Teaching Programme (GTP), too often I initially get the impression that a 'good' lesson that the trainee wants me to see is one where the pupils work in silence for much of the time and get through large amounts of work from the set textbook. Indeed, some of the pupils may be 'playing truant in mind whilst present in body' (Young 1984: 12). Quite often, this is not the trainees' fault directly – school or departmental expectations are such that it is not unusual for pupils to work in silence whenever possible, justified on the grounds that this might develop their ability to work independently and (often unsaid) not disturb or distract other pupils.

This research includes my experiences visiting schools. In one school that I have visited (a well-known and highly praised academy) I was told by a senior member of the Mathematics department, when I queried some of the activities on the trainee's lesson plan, that there is a specific requirement that the pupils work for at least half the lesson in silence. It might therefore be useful to determine whether those schools that have an expectation of working in silence like this are successful. In the international performance tables (PISA) which compare the performance of 15-year-olds in their ability to apply their mathematical knowledge to 'real-world' situations, we are moving down. 'In 2000, the UK was placed eighth in maths and seventh in reading – the UK in the latest table (2004) is in 24th place for maths and 17th for literacy.' (Online: <http://news.bbc.co.uk/1/hi/education/7115692.stm> [accessed 30 August 2011].) It appears that the countries which seem to perform better in maths are those whose schools are positively encouraged to 'believe that everyone can be good at maths and their teachers work to make sure that happens' (Boaler 2009: 34).

Psychology of talk in learning

In England and Wales, when a child first goes to school, most learning takes place through structured activities which may appear to be play. The importance of this has been highlighted by the QCA: 'There should be opportunities for children to engage in activities planned by adults and also those that they plan or initiate themselves. Children do not make a

distinction between "play" and "work" and neither should practitioners' (QCA 2000). These activities are often group-based and designed to develop simple concrete associations of number and counting (Piaget 1955, 1972). As the child gets older and moves through the educational system, she/he may be put into some form of ability group (such as 'ability tables'). Growing older, progressing through primary school and on to secondary school, the child may have already gained a label indicating mathematical prowess. The inevitability of the self-fulfilling prophecy springs to mind. This is usually reinforced when children are placed into ability sets, which often happens within a few weeks of arriving at secondary school.¹ These sets are usually based on a mixture of outcomes from in-house tests and cognitive ability tests and their Key Stage 2 (for ages 7–11) results and reports from the feeder primary schools. Most children will remain (more or less) in the same level of ability set for the whole duration of their secondary education.

Passive learning (teacher-led, transmission models, where the emphasis is on teaching (Chambers 2008)) can often give the appearance of good learning, i.e. the lessons are generally orderly and the pupils in the class will usually appear busy, as, for instance, when completing 'low-level tasks which are mechanistic and can be completed by imitating a routine or procedure without any depth of thought' (Ofsted 2002: 27). The format of the lesson may look something like this: There will be a starter activity which may or may not lead towards the lesson's theme. Then the teacher will expound: the aims and objectives, the introduction of the first activity with some rules and examples, then an exercise (often from the preferred textbook). This is followed by a second (sometimes third and fourth) exposition and exercise. It is then neatly wrapped up with a plenary activity, which is intended to summarise the learning for that lesson, the pupils having worked quietly on their own. To the untrained observer this might be considered a good lesson. Knowledge has been imparted, something has been written down and some questions have been answered. As far back as 1982, the Cockcroft Report said that 'it is very easy for ... teaching in mathematics to depend too much on exposition by the teacher and for students to adopt passive forms of learning' (Cockcroft 1982: 561). There has been, as indicated by the Cockcroft Report, a long-held concern about the efficacy of the passive, transmission style of lesson.

The alternative to a passive lesson is an active lesson. An active lesson is one where the children in the class naturally interact with each other. The lesson may apparently start in a similar fashion to the passive lesson – with starter activities and some teacher exposition – but for the rest of the lesson the teacher may not

be obviously leading the lesson. Pupils will probably be working in groups of some kind – but not always. The teacher may want to provoke discussion. ‘Class discussion is easier to manage ... simply because the teacher is an active part of the whole-class discussion’ (Chambers 2008: 107). They will share ideas about the tasks presented to them. There will be an expectation that they will achieve some clearly defined objectives, which are often clarified by very clear statements of expected learning outcomes. Many schools use the acronyms WALT and WILF (We Are Learning To...; What I’m Looking For). The teacher’s role will be to circulate: listening, prompting, assessing, offering further information or ideas as necessary. At certain points, dictated by the common need for clarification or further input, the teacher will stop the activities and by means of considered (and possibly targeted) questioning will allow the learners to expound on their progress thus far. These are recognised Assessment for Learning strategies (DCSF 2008). This might be in the form of presenting and discussing their outcomes so far, answering further challenges posed by the teacher, or by rehearsal of the processes they have been using. Any new inputs can then be offered, to develop what has occurred so far. But – none of this is achievable without the pupils having the confidence and ability to talk about the maths.

The purpose of talk

It follows that there is a need for children to talk, and that talking is natural. When observing lessons, I like to hear that ‘buzz’ or working noise from the pupils. This indicates that the children find the work interesting and challenging and that they want and need to talk about it as Chambers notes: ‘well-focused group work helps pupils to verbalize their ideas to others. They may then be required by other members of the group to justify their ideas in more detail’ (Chambers 2008: 107). It is important to remember that the trainee teacher should also be circulating in order to support and assess pupils’ activities and discussions.

When I was Head of Maths, in a comprehensive school in a London borough, together with one of my colleagues, I used some of the ideas of Polya² (Polya 1971) to form the basis for lessons in problem-solving. We wanted the children to explore using maths, rather than just practising skills, so we tried to put his ideas into practice and help them formulate a way of working to solve problems. The key ideas were what he called ‘four phases’ (Polya 1971: 5). These four phases were: understand the problem; make a plan; carry out the plan; look back at the completed solution. We devised some short problems and adapted others so that

the pupils could try the techniques we had distilled from Polya’s work. We came up with a simple routine, which would help our pupils get started to solve problems using mathematics, as we quickly realised that the major problem was ‘where do we start?’ In pupil-friendly terms, our routine was:

- Look at the problem – what have you been told?
- Can you see a simpler starting point?
- Try some simple ideas and build on them in a logical manner
- Record outcomes logically (tables are good!)
- Can you see any patterns in your outcomes?
- Hypothesise (make a guess what is happening)
- Try it out
- Generalise – in your own words, then mathematically.

At all the stages we insisted that the pupils talk to each other – explaining what they were doing, what they had found and what to do next. It took some time, but pupils eventually saw they needed to talk in order to share and learn from each other. We realised that this was in many ways a more powerful way of teaching and pupils were more engaged with maths than previously, when they had been simply completing textbook exercises or worksheets.

It is important to remember that the National Curriculum for England and Wales (NC) specifies subject contents but not teaching methods. It does, however, mean that planning becomes (even more) important, as lessons need to be designed in a constructivist style. As Chambers says, ‘Discussion, therefore, becomes a central part of learning, much more than the teacher transmitting knowledge’ (Chambers 2008: 102). Vygotsky’s ‘zone of proximal learning’ clearly suggests that learning takes place, and is reinforced, when children work collaboratively (Vygotsky 1978). Collaboration has to be both with their peers, as well as with ‘experts’, i.e. teachers. There is also an implication that consideration has to be given to pupils’ preferred learning styles – visual, auditory and kinaesthetic (Chambers 2008: 69) – and to gender-different learning (Chambers 2008: 152). Work has to be presented so that all pupils can access the tasks and contribute to the outcomes.

An excellent example of this is a lesson I observed about two years ago. This has been used as a case study for initial teacher education (ITE) trainees on the use of talk in lessons. One of the graduate trainee teachers was teaching an introductory lesson on probability to a Year 8 class. His planned learning outcome was to make the children confident in understanding the

probability scale using descriptors. His starter activity was a simple oral task, where some statements were displayed on an interactive whiteboard (IWB). Initially pupils had to decide, using their own words, the likelihood of each event (statement). These were shared with everyone. In groups the pupils were then asked to put the list of statements into some order that represented the likelihood of each event compared to the others. He also provided some common terminology for them to use. In their groups, the pupils were all able to put the events into some order and these outcomes were shared with the class. The whole class was then asked if they agreed with the ordered lists from the other groups or would suggest any reordering, with a reason. The outcome was an agreed order that all were happy with. From this, pupils were able to understand the differing terms used and the hierarchy of the terms. All the pupils had contributed, either within their groups, or within the class discussion. All were confident and able to move on to the next activity, where the groups had to order the probability of a range of events. Five minutes before this activity was planned to end and while the groups were still discussing their outcomes, the teacher nominated one child from each group to visit another group to share outcomes. After a few minutes, the 'visitor' returned to their own group and reported back on what had been gathered. Each group could then decide if it wished to modify its outcomes in any way. When the pupils were asked to feed back to the whole class, there was almost 100% agreement. What was also impressive was the confidence of the children in reporting back – no one seemed to be worried that a 'wrong' answer might be given.

Types of pupil talk

The idea of talk needs to be considered, i.e. what is important is its content. Pupils can be invited to talk in several different ways. The most commonly occurring will be responding to questions or stimuli presented by the teacher. This form of talking will be present in virtually all lessons, with all teachers in all lessons. This should not be a problem, provided that all pupils have an opportunity to participate (Chambers 2008: 107). Another type of talking is reflective, where children are asked to consider (reflect on) some problem, a set of facts presented to them or discussions within a group. The pupils may then be asked to feed back their reflections either to the teacher directly, or to one or more peers. If feeding back to peers, then firstly some discussion should take place before feedback is offered to the whole class via a spokesperson. This can often lead to a class discussion. This can be considered as part of Vygotsky's concept of the 'More

Knowledgeable Other' (MKO) in the 'zone of proximal learning' (Vygotsky 1978) as input is being offered to improve understanding. This suggests that problem-solving skills can be placed into three categories: those performed independently by the student; those that cannot be performed even with help; and those that fall between these two extremes that can be performed with the help of others (Vygotsky 1978). Reflective talking has similarities to a third type of talking – open, peer-to-peer discussion. Pupils have to feel entitled to offer thoughts that will be listened to and not disparaged, or they will withdraw from the activity. At different times the role of the MKO can be taken on by different members of the discussion group. How the group itself is constructed is also important – there are many ways to structure group membership, and time has to be allowed to find the most effective pattern for the particular activity. What has to be present is that entitlement to express thoughts or opinions. Hatch says 'It is... placed firmly in the arena for others to comment on, to make the attempt to refine or refute it' (Hatch 2002: 138). Pupils need confidence both in themselves and others in their group in order to do so.

Conclusion

There are several requirements if talk is to be successful. The first is the skill to be able to listen. This is not a passive activity – in the context of a lesson it means thinking about and attempting to process what has been said (Pollard 2002: 295). For many children, this is not always easy! Many teachers require a few seconds of reflection before any response is offered. Secondly, the talker must not be interrupted, as interruptions can break the chain of thought the talker is trying to convey (and are disrespectful). The third requirement is the skill to respond in a non-disparaging way. All of these need to be established, with appropriate 'rules of engagement'. Once they are established, then talk in lessons becomes effective.

Notes

¹In England and Wales, the education system is generally age-based: from 4 to 11 is the primary phase; from 11 to 16 is the secondary phase. Post-16 education can be in school sixth forms, sixth-form colleges or further education colleges.

²George Polya (1887–1985) Professor of Mathematics, Stanford University (USA). Noted for work in heuristics and mathematics education.

References

- BBC News (Education) (2011) *PISA rankings (pupil attainment)*. London.
- Boaler, J. (2009) *The elephant in the classroom: helping children learn and love maths*. London: Souvenir Press.
- Chambers, P. (2008) *Teaching mathematics*. London: Sage.
- Cockcroft, W.H. (1982) *Mathematics counts*. London: HMSO.
- Department for Children, Schools and Families (DCSF) (2008) *The Assessment for Learning strategy*. London: QCA.
- Gates, P. (ed.) (2001) *Issues in mathematics teaching*. London: Routledge.
- Haggerty, L. (ed.) (2002) *Teaching mathematics in secondary schools*. London: RoutledgeFalmer.
- Ofsted (2002) *Mathematics in secondary schools*. London: HMSO.
- Piaget, J. (1955) *The child's construction of reality*. New York: Routledge & Kegan Paul.
- Piaget, J. (1972) *Psychology and epistemology: towards a theory of knowledge*. New York: Penguin.
- Pollard, A. (ed.) (2002) *Reflective teaching*. London: Continuum.
- Polya, G. (1971) *How to solve it*. Princeton, NJ: Princeton University Press.
- Qualifications and Curriculum Authority (QCA) (2000) *Investing in our future: curriculum guidance for the foundation years*. London: QCA.
- Vygotsky, L.S. (1978) *Mind in society: development of higher psychological processes*, ed. M. Cole, V. John-Steiner, S. Scribner and E. Soubberman. Cambridge MA.: Harvard University Press.
- Young, D. (1984) *Knowing how and knowing that*. London: Birkbeck College.

Contact: t.pye@uel.ac.uk